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## Facing the challenge in evaluating technology use in mobile environments

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# Facing the challenge in evaluating technology use in mobile environments: Supporting first-aider training

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**Abstract.** Developing innovative mobile approaches to informal and formal learning raises a challenge to satisfy various stakeholders. Evaluations may focus on examining the nature and quality of learning that occurs when using technological systems, other methods are targeted towards user interactions with the systems. In this paper we highlight a methodology that attempts to address these two analytical issues in parallel, and communicate the results across stakeholders. The methodology is grounded in cultural historical activity theory and is compatible with other views emerging of such evaluation as having multiple levels. The method applies task analysis to examine the conflicts that emerge when learners are interacting with technological systems in an informal learning setting. Results from a trial involving first aiders are used to illustrate the techniques as they were applied as part of a European project that developed a collaborative mobile learning environment and results from. The method has been repeated in other studies and can provide a tool to help reflect on understanding and enable the sharing of perspectives on evaluation outcomes.

**Keywords:** Mobile learning, activity theory, trials, task model

## INTRODUCTION

Our experience of evaluating technology enhanced collaborative learning over a period of years has highlighted a difficulty shared by many researchers. In complex multi-disciplinary projects comprising a variety of professionals from different fields (e.g. teachers, researchers, software designers, programmers, system builders, pedagogy experts) it is hard to find an appropriate common language to enable the project's work to run smoothly, and in particular to facilitate the evaluation. Carroll (2000) discusses this problem, and recommends the use of scenarios as boundary objects to help overcome the difficulties. Scenario-based design entails using concretisation – a concrete story of use. This story typically specifies a setting; objects; agents or actors and their goals or objectives. They also have a plot. Scenarios may be very short, focusing on a small piece of interaction with a system, or they may be quite elaborate.

The main point about scenarios is that they provide a coherent and concrete vision, and 'not an abstract goal, not a set of requirements, not a list of features and functions' (p.50). Carroll also notes:

'The problems of managing novelty and complexity in design are no doubt exacerbated in cases [where] the technological issues [are] quite novel and tangled and the team large, diverse and distributed.' (p. 8).

In working with learning technology the case described by Carroll is not rare; the development of novel systems and the complexity of working across disciplines is a necessity if learning technology is to be adopted and refined. The focus of this paper is a European project where the team was multi-national, multi-lingual, multi-skilled and distributed across Europe, trying to build a system that orchestrated new and emerging mobile technology to construct a pedagogically sound mobile learning environment. The challenge of organizing, managing, developing and testing such a system is clear and led to pressures to have in place robust and clear approaches for defining and evaluating.

As leaders of the user requirements and evaluation workpackage, a starting point was to make use of scenarios, as prescribed by Carroll, to help communication and to enable pedagogy experts to communicate with system designers and builders. But as the work developed, we found that a **task model** we had constructed as part of the design process (Taylor, Sharples, O'Malley, Vavoula and Waycott, 2006) also proved its worth in

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terms of the implementation, or instantiation, of the scenarios, and then led into an evaluation process that emphasised communication.

Some of the reflection on this (and other work) has been reported by Vavoula and Sharples (2009) who set out six challenges restated here in brief as: capturing contexts; identifying learning; satisfying ethical concerns; incorporating mobility; establishing an overview; and, linking formal and informal. They then provide a three-level consideration of the evaluation process as having micro, meso and macro levels. The need to switch between these different perspectives provides an overall communication concern – how can those who engage at one level understand the impact on those working at a different level. When the need to work on different levels is combined with the different interpretations from disciplines, roles and interests of stakeholders, tools that help extract and share these views becomes a vital component in implementing the evaluation approach suggested in the paper.

The task model enabled us to develop a framework that attempted to satisfy various stakeholders when evaluating learning and technology use in informal settings. It is a method for representing user activities (practices, strategies and conflicts) that emerge when interacting with technological systems in an informal mobile learning setting. The task model represents both a **semiotic** and a **technological** space, which are mutually dependent, but which can be described separately. The model is rooted in cultural historical activity theory, and develops Engeström's (1987) extended model of human activity. A particular contribution is to build a visual representation that exposes the activity structure as viewed from more than one perspective.

We go on to provide some background firstly to the project (MOBilearn), and then to the first-aid user trial.

## THE MOBILEARN PROJECT AND FIRST AID SCENARIO

MOBilearn was a large, multinational, European-funded research project involving more than 15 organizations from seven European countries, and one Middle Eastern country. The consortium comprised both industrial partners and universities, and brought together areas of expertise in technical design and implementation; and pedagogy and evaluation. Taking a user-centred approach, the aim of the project was to define an architecture for a pedagogically sound mobile learning environment, and to evaluate an instantiation of that architecture using currently available mobile technologies.

In Taylor and Evans (2005) we discuss some of the problems encountered in working in such a large project, spread across the world, and how scenarios were used both to help structure the project's activities and to help focus design effort. Scenarios in the project fulfilled a dual function.

- **The first was to assist in the process of 'envisionment' (Carroll, 1995) of the mobile learning environment.**
- **The second was to begin considering basic requirements to enable us to progress towards the field studies that will provide us with user requirements in the user-centred context.**

The project had identified three target domains for study and development. These were Museums (including Art galleries), First Aid, and MBA students attending a university business course on a part-time basis. These domains are representative of a range of applications related to mobile learning, with particular reference to learning outside the classroom.

The work with scenarios was carried out in the context of the socio-cognitive engineering design method (Sharples et al 2002), a user-centred approach which describes and analyses the complex interactions between people and computer-based technology, so as to inform the design of socio-technical systems (technology in its social and organisational context).

Figure 1 gives a picture of the flow and main products of the design process. It is in two main stages: a stage of **activity analysis** that sets constraints on the design and analyses how people work and interact with their current tools and technologies; and a stage of **design of new technology**.

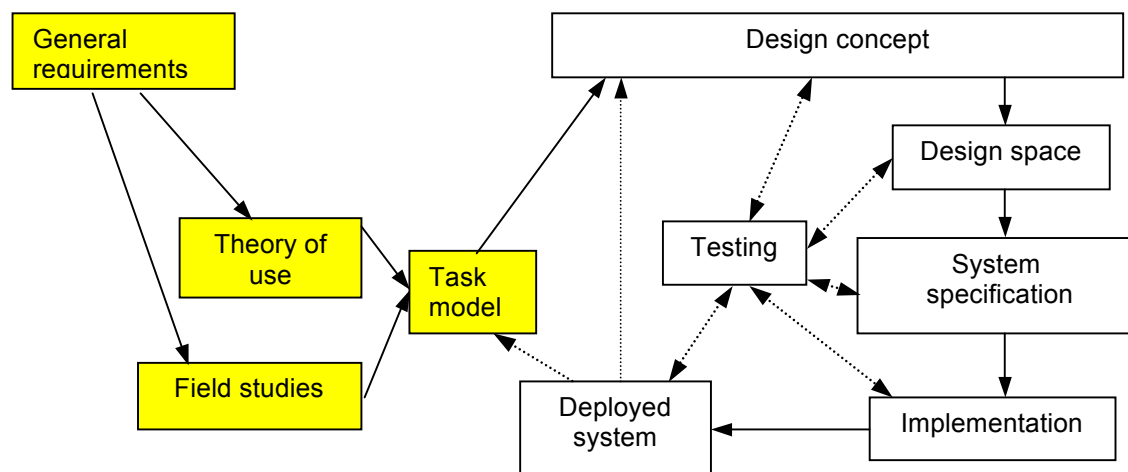


Figure 1: Overview of the flow and main products of the socio-cognitive engineering design process

The focus for this paper is on the **activity analysis** aspect. As illustrated in Figure 1, general requirements were collected for each of the three scenario strands, which were collated and stored in a database using a template based on the Volere method (see Sharp et al, 2003; Haley et al, 2004). The requirements contributed to a theory of use, along with the scenarios, and these two sources of information allowed us to specify the field studies that would feed into the task model, and onward to the design of mobile learning environment. In this paper, we use the First Aid scenario to describe the field studies, how they were run, how they were analysed, and what we were able to learn from this process. The museum scenario is considered in another paper (Sharples, Taylor and Vavoula, 2007) which explains the overall aims of the project and the framework adopted in the activity analysis.

### The first aid scenario

The training of people prepared to give first aid to people suffering an accident at work was chosen as one of the application areas for considering mobile learning. Training is a requirement for anyone who wishes to take the nominated role as a first aider and typically happens every three-years during a one day face to face workshop. This training is provided by organizations such as the St. John's Ambulance.

The training is highly regarded but the opportunity to apply that training in a real accident may be very rare, and contact between those carrying out first aid may also be fairly low as each person typically has a fixed area of responsibility within the work place. This makes such training suitable for top up training that can happen less formally in-between formal training sessions. The MOBIlearn project therefore considered this as one of its three main application areas for developing scenarios for mobile learning. User views were elicited through Future Technology Workshops (Vavoula and Sharples, 2006) and a series of detailed scenarios were built (Taylor and Evans, 2005). The scenarios fed into a requirements process jointly with scenarios from the other application areas (museum visits, and supporting campus-based business students) to specify a software solution able to support the training scenario.

At the same time the scenarios were developed into a plan for a trial using a group of first-aiders who have the role of 'Designated First Aider' for their department within the Open University (OU). This means that in addition to their normal job role they deal with first aid incidents in their department or around the OU. Training is voluntary, and in discussion with the first-aiders it was found that, whilst their training needs to be up-date, and, annually refreshed and tested, there was little opportunity to practise their skills in the normal run of things at work. This was particularly the case for more dramatic incidents, such as heart attack, when being able to take immediate and appropriate action would be of critical importance. They met on a regular basis to refresh their training, but felt they wanted to get a better feel for what it might be like in reality. We felt that mobile technology could offer some possibilities for providing stimulating training exercises, conducted in situ (rather than in an assembly hall, or other meeting place), and the design of the trial aimed to address this issue.

The scenario that was developed was activity based: users would be faced with challenges and would need to draw on knowledge, collaborate together and communicate to meet those challenges. The MOBIlearn system would support them in this, by offering content, access to a moderator and each other, and a range of communication tools available through a single device.

## ANALYSIS METHODOLOGY

### Activity Theory

Within the MOBIlearn project, a task model for mobile learning was developed as part of the socio-cognitive engineering design method (Figure 1). This method draws upon socio-cultural theories of learning, and, in particular, that of activity theory (AT) as expressed by Engeström (e.g. 1987).

Within AT, the introduction of a computer-based system to manage and support work practices ought to enable participants in that community to identify with objects or information resources relevant to that work context. The significance of this notion emerges from the dialectic which is introduced - the process of interacting with objects using computer-based tools enables transformations to occur in both the objects and also in the individuals involved in carrying out work activities. Transformations in objects tend to be physical in nature, whilst individuals involved in carrying out work activities using computer-based tools can experience changes in their perceptions of the objects and also of the activity that they are performing. In activity theory literature, this notion of transformation has been discussed in relation to changes that occur between tools and tool-users, the activity being performed, and also the objects being manipulated during activity (Engeström, 1993; Kaptelinin, 1996; Engeström and Escalante, 1996). Consequently, transformations in objects and activities can result in changes in work practices. Such changes can become evident in tool usage behaviour. As a result, contradictions are bound to emerge in the way work activities are carried out. This could have an impact on the kind of outcomes resulting from that work activity. Engeström (1993) positively highlights this line of thinking by arguing that contradictions or discrepancies serve as a means by which new insights about developmental patterns of human practices emerge. Therefore, systems for supporting work practices should be designed with a technological infra-structure that is socially transparent and sensitive to both collaborative and individual working styles, and preferences so as to accommodate discrepancies in work practices.

Engeström's activity system is illustrated in Figure 2. The extension of the triangle from the original Vygotskian 'subject/object/tool' triangle allows a more complex analysis of the context of the activity by examination of, for example, the 'subject/rules/community' sub-triangle.

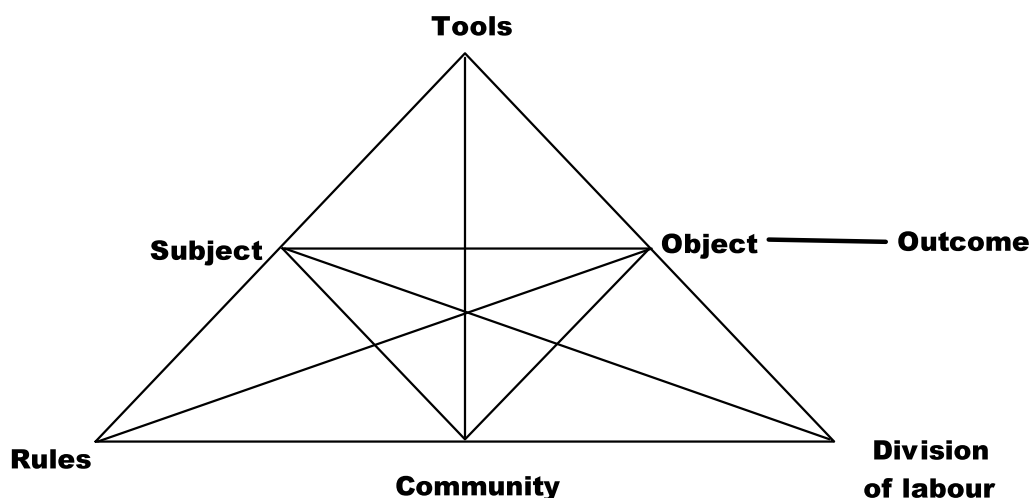


Figure 2 – Engeström's (1987) extended activity system

### Adapting the Extended Activity System

Although some researchers have found the activity triangles inspiring, but difficult to use in practice (Scanlon and Issroff, 2005), others have explored ways of operationalising them and applying them in practice. Papadimitriou et al., 2007, consider the activity structure as a way to develop rich descriptions of separate activity. Mwanza (2002a) discusses ways in which the nodes of sub-triangles can be formed into questions: e.g. 'in what way are the **rules**, and the **community** affecting the **subject's** behaviour?' The triples can have different emphasis: e.g. in what way is the **subject** interacting with the **community** to interpret the **rules**? We see our current work as moving further in this direction.

Several adaptations were necessary for us to use the representation effectively.

1. We treat the main, top-level labels as variables to be instantiated from the situation under scrutiny. This means that a given instance, when fully instantiated, will act as a snapshot, containing a great deal of

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information about the situation. These snapshots can represent the same situation from different points of view (e.g. the first aid trainee's view, and the trainer's view). The process of instantiating the labels on triangles is as principled as we can make it without being formal – it may not always be correct, and we may not always achieve consensus on what is the appropriate term – but it is not random. The triangles are used to instantiate the scenario descriptions (we will go on to describe this process below) so there is a relationship between the activity and its representation, articulated as a narrative. As data comes back from empirical work, so we can adjust the labelling to increase the goodness of fit to the activity as it happened.

2. We needed to introduce an additional layer to the diagram to represent the corresponding technical activity underpinning the semiotic activity (described below).
3. We became aware that the current labels on the triangle were not helping to engage people from different walks of life. The terms 'rules', 'community' and 'division of labour' for example, implies a political position that is relevant to the derivation of activity theory but unfamiliar and incongruous in the software design and implementation communities. We therefore replaced the bottom 3 node labels with the terms: Control, Context and Communication.

The changing of labels on the triangles is explained further in Sharples, Taylor and Vavoula (2007), in making this change, we wanted to make the representation more intelligible to our colleagues, but we also wanted to stay within the ethos of Activity Theory. The term 'Control' relates to the notion of 'rules' but also allows a cybernetic sense of control appropriate to the computing world. **Control** may be passing between the computer and the learner, or between programs at the technological level, or between people at the semiotic level. This is a much richer concept than simply who can do what, and when, but this element is subsumed by it. Similarly, learning takes place within a **context**, and as our learning theory is socio-cultural, the community within which it takes place is of primary importance, so a connection is maintained there too. On the other hand, the context will have many other things associated with it besides community, some in the purely technical sense, some not. For example, many mobile computing applications are able to automatically sense aspects of the environment (such as other people, other devices, other objects, location awareness, proximity etc.). These all feed into a concept of context for our studies, and we need a way to capture this.

The division of labour is often something to be negotiated – not always, but often. Again, this is a complex concept which is further complicated by the presence of technology. The apportioning of activity between participants, and between participants and computers, will depend upon the communication links between them, so division of labour is again subsumed by the label '**communication**' but not left out.

### The Task Model: Semiotic and technological spaces

The Task Model developed for the MOBIlearn project embodies a central concept of mobile learning, derived from our empirical work, which is:

- **there is a clear separation between required functionalities and their embodiment in any specific technology.**

In other words, in a work situation or a learning situation, people know what kinds of functionalities (resources for learning) they would like to have available to them to be effective, and will seek these out as and when they need them (e.g. a web browser, a word processor, email etc.). We also adopt the view of mobile learning expressed by other authors which is that:

- **it is the people that are defined as 'mobile', not the devices around them** (e.g. Sariola et al 2001)

Taylor et al (2006) argue that mobile learning, then, is something that people do on the move, using whatever they may have to hand to do it – handheld devices, PDAs, laptop computers, telephones and notebooks - including paper. Mobile learning then, for us, is not simply defined by the fact that someone has a mobile device. These two principles lead us to a representation of a mobile learning space which separates the technical view of the activity, and its enabling technology, from the view of the human learning activity, embedded as it is in a social and cultural milieu (see Taylor et al, 2006; Sharples, Taylor and Vavoula, 2007; Sharples 2005 for more detail). Learners move within these two spaces - the mental space which consists of required, or preferred, functionalities, and the space of possible actual embodiments of those functionalities in the form of devices. There is a dialectic between these two spaces – if the learner sees that a device has a good match to her requirements, she may choose to appropriate that technology and in so doing, integrate it into her activities. As she integrates the device, her activities will be shaped by it (see Waycott (2005) for an account of how this process can occur).

So there is a dialectical relationship between the technological space, and the more abstract semiotic 'learning-space'. Learners enter the task of learning with an objective – to augment knowledge and skills they may or may not already possess, and the output from this activity is a new set of knowledge and skills. But several other important factors impinge on this rather simplified process. The authors argue that these other factors share the same dialectical relationship between a technological (or physical) domain, and a more abstract human, social – or as they describe it 'semiotic' – domain.

Figure 3 illustrates the top level task model, instantiated to the first aid scenario.

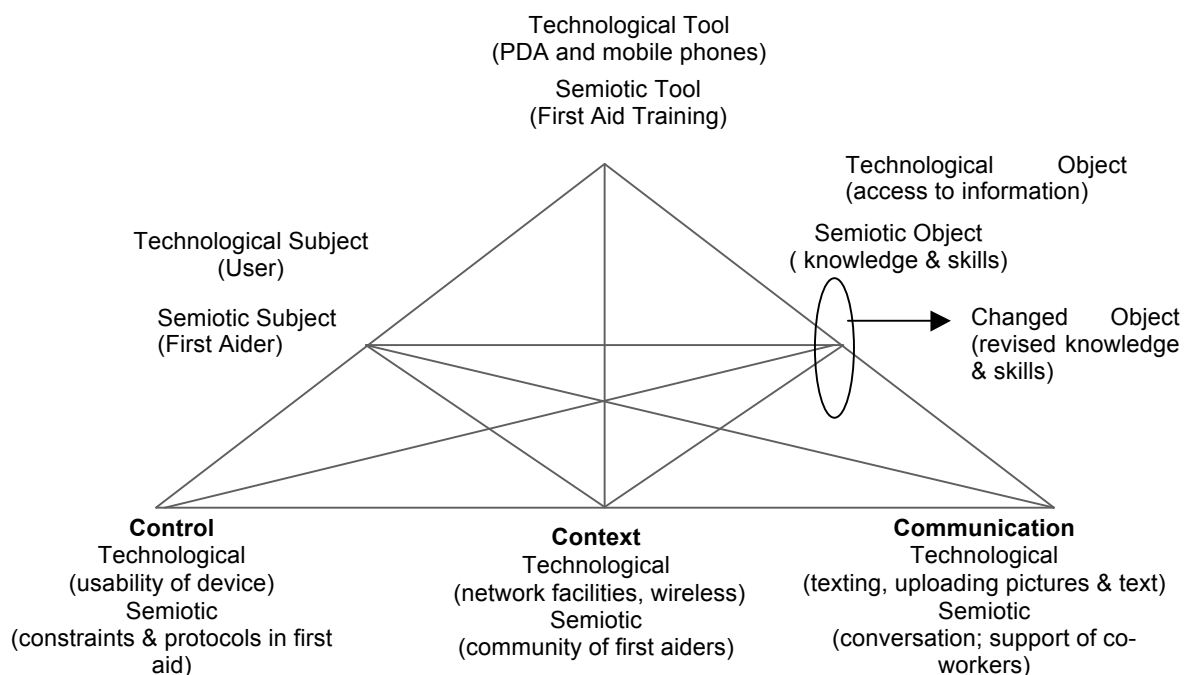


Figure 3: the task model representing the first aid scenario  
Because the task model is representing two spaces, however, this representation is actually one triangle laid upon another. Lifting them apart makes it easier to see the two levels, and to identify the points at which the dialectical relationship occurs between the semiotic space and the technological space, as shown in Figure 4.

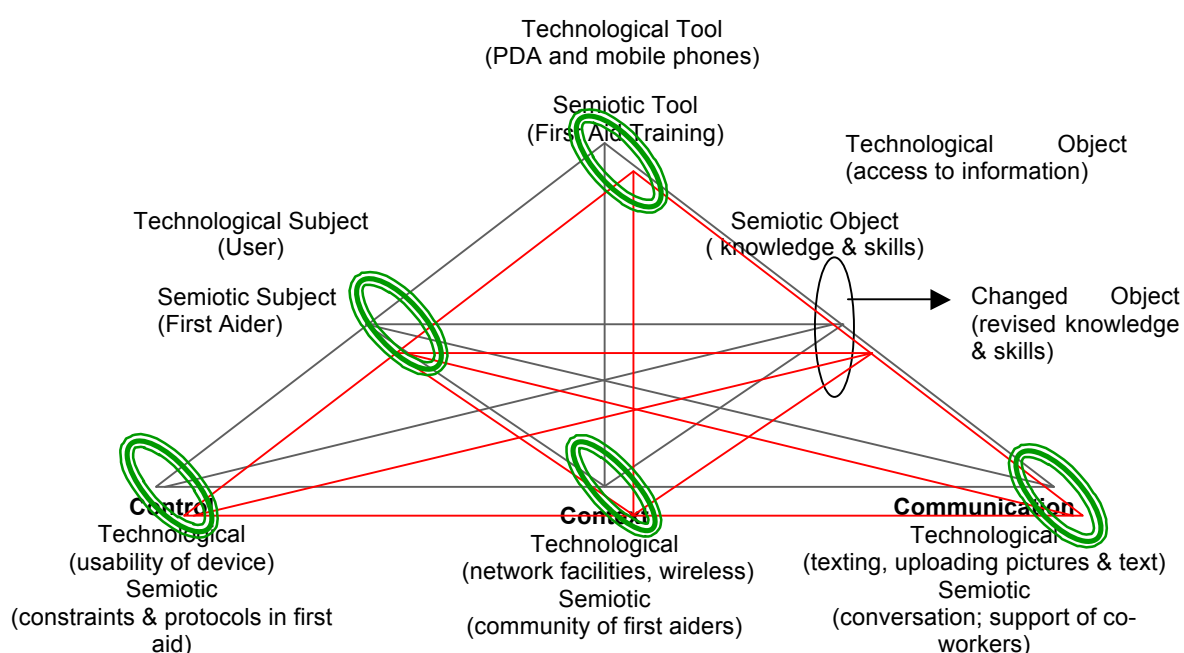


Figure 4: the task model showing two levels and dialectical relationships

This representation of the mobile learning task facilitates analysis of what is happening at any given time, and is particularly helpful in evaluating learning events because it allows the evaluator to separate out those incidents which have to do with the technical infrastructure from those which are associated with the learning event itself. We can also see the impact of failures of technology on the learning activity – sometimes it matters, and can be fatal for learning, and other times it doesn't. This issue will be taken up again later when we examine the outcomes of the user trials.

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A few further points are important. Whilst there is a proposed dialectical relationship between nodes in the two spaces, there are also relationships between nodes of the triangle on each individual plane – this illustrates the complexity of the situation we are examining. We are not discarding the more traditional way of using the triangles to look at activities and their sub-structure (see earlier discussion). On the whole, however, if our discourse refers to the ‘First Aider’, the semiotic plane is indicated; if we refer to the ‘User’, the technological plane is indicated. The main purpose of the representation is to surface contradictions and difficulties. So, for example, in an ideal world, the semiotic First Aider would never need to be explicitly aware of the presence of the technological layer. It is just there, doing its job, facilitating her activity. If there is a breakdown, however, the semiotic First Aider needs to become the technological User in order to try to fix the problem – if she can. Quite a few First Aiders lack competent User personas that can step in at this point to fix things, so a technological failure can be catastrophic.

## **APPLYING ACTIVITY ANALYSIS IN PRACTICE**

We applied our two-layer analysis to a series of trials using software developed in the MOBIlearn project and known as the "MOBIlearn system". For the first aid scenario there were two linked trials with activity analysis used in each case to provide feedback and help us understand the issues that emerged.

### **Trial 1**

In trial 1, the first performance of the first aid scenario, the trial took place in pressured circumstances that are not untypical of experiences in developing research software within projects. In this case the project was nearing completion; the software integration stage had been delayed; and, there were performance issues and uncertainty as to whether the software should be accepted for use. This led to compromises in the structure of the trial in that the participants were not approved First Aiders, and the number of participants was kept low. The scenario was adjusted to apply to a group of four technical support people from within a single department, all of whom with an interest in first aid but without formal certification. These compromises meant there was additional pressure to get as much as possible out of this trial in the form of evaluation data and feedback to the developers so that rapid changes could be made for trials with other scenarios and a re-running of the first aid scenario.

For the trial there are two types of user: a task leader and a task participant. The task participants are expected to interact as pairs and as a complete group. The task leader needs to configure the tasks and interact with all participants to guide them. Figure 5 shows the agenda for the activity. In brief for each task the participants were directed towards appropriate content and tools within the MOBIlearn system. The task participants needed to carry out individual tasks (Quiz, testing their knowledge of first aid in relation to content in the system), paired tasks (the challenge and brainstorming, to work out a joint response to an emergency situation), and work as a complete group (initial chat and get together and vote, when they would need to review each others suggestions). The task leader was responsible for constructing the agenda, overseeing activity during the chats and setting tools to appropriate states – e.g. closing the vote at the end of voting.

A familiarisation session was run for all participants to give them general experience with all facilities in the system. They were able to use a wide range of tools and encouraged to give usability feedback. The main trial session then used a narrower set of tools and encouraged feedback on functionality and task performance. The task participants were separate and physically distant, but worked together in pairs through the system. To aid evaluation, video recording captured the interaction of each pair who were also watched by an observer who made notes. The task leader was part of the project team and made reflective notes. A debriefing session involving all participants and observers was video-recorded. These sessions were then reviewed to highlight key incidents and identify the views of the participants.



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OVERVIEW


Title					
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<a href="#">G2: Brainstorming</a>				<a href="#">open</a>	<input type="radio"/>
<a href="#">Get together and vote</a>				<a href="#">open</a>	<input type="radio"/>

Figure 5: Agenda for tasks in trial 1 presented in the MOBILearn system

### Semiotic and technical view of the trial

The scenarios and planned actions give a narrative view of the trial that can be represented in the semiotic layer of the activity system described above. Essentially each of the six nodes of the expanded Engeström triangle can be given a label or set of labels. The difficulties in operationalising activity theory in this way has been recognised in other research (Mwanza, 2002b) and indeed there will be no single unique way to label the triangle. This illustrates a difficulty in the technique, as described earlier. However there will be an implicit view of intended activity in the design and the act of mapping it to the triangle can be achieved in a rapid brainstorming fashion. The result should then be treated as a tentative labelling that is open to revision during further analysis very long sentence – can it be split into two. Similarly the technical view representing the system could become very complex if all possible labels are applied and in practice only a partial labelling is possible. A rapid approach to labelling again proved effective to generate node labels of those aspects of the technology likely to concern users in this particular trial. This meant that the technical and semiotic views were roughly balanced and related: a different scenario would be expected to lead to both a different semiotic view and a different technical view.

### Analysis of the trial

In broad terms this trial, and other trials taking place on other scenarios, were successful, in that users had accessed the system and carried out some tasks. However, there had been some basic problems of system responsiveness, and users had difficulty finding the correct menu and methods to select the tools that were expected by various tasks. The first aid trial in particular had not been able to progress through all stages in the expected time. An initial reaction within the project was to generate some recriminations and an urge to “fix” problems with the user interface. There was a feeling that the either the system could be blamed, along with its developers, or the specification could be blamed, along with those who built the scenarios. While this is in some ways a natural reaction to faults late in a system’s development, the two-layer view of activity we have discussed offers a suitable means for determining and explaining more subtle interactions between elements in the system that are causing contradictions for the user. These can then be addressed both through adjusting the technology and the trial design. Presenting the evaluation results in this way also encouraged shared understanding of the problem viewed across both layers and joint working towards a solution.

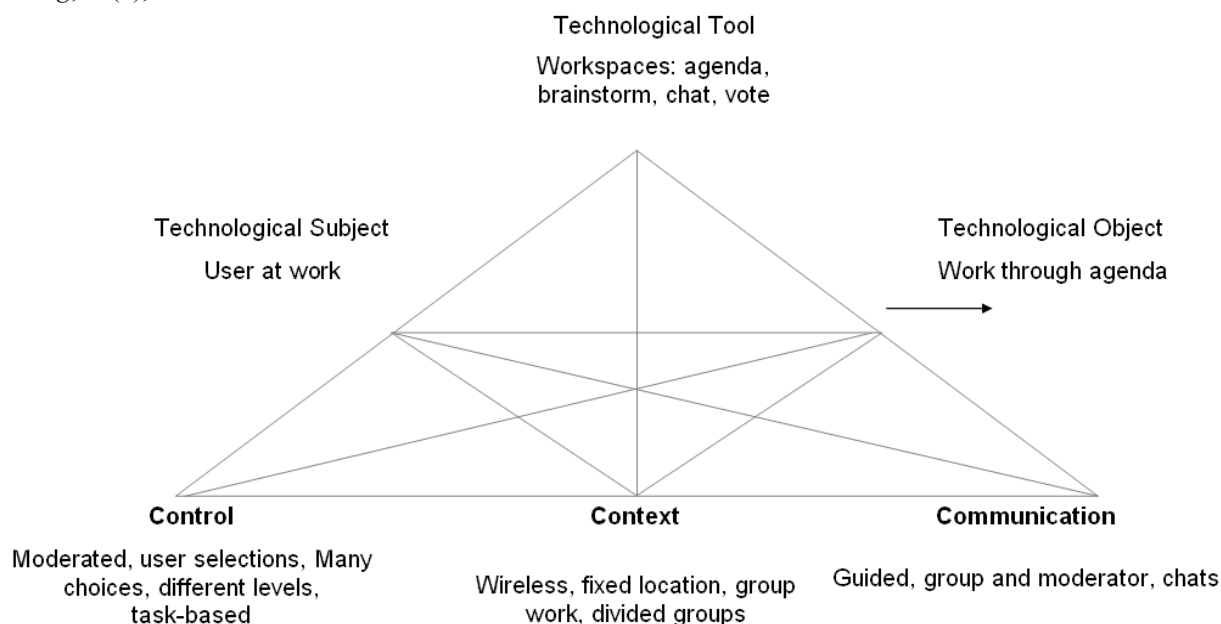


Figure 6: Technological view of trial 1

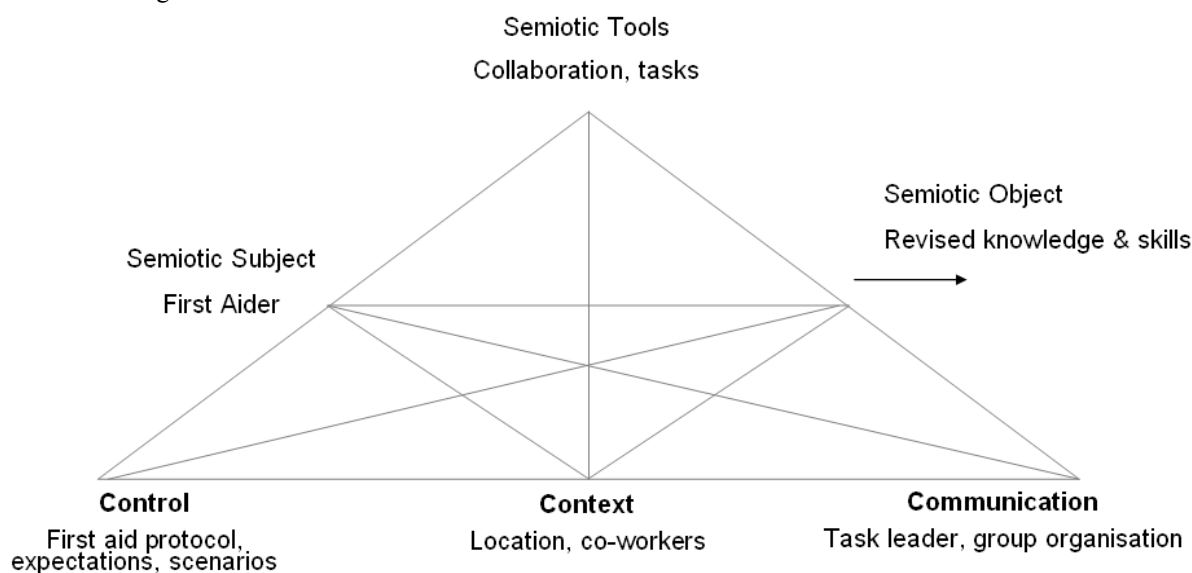


Figure 7: Semiotic view of trial 1

For this trial we developed a technological view of the system, as shown in figure 6 and a semiotic view, figure 7. These use a representation of the activity triangle that has multiple labels at each node as a mechanism for sharing the understanding of views of the system. In effect each triangle shows many different interactions that can be separated out and used to identify and explain cases where different aspects can act in support or contradiction. Having labelled the triangle we looked at the feedback and observations in relation to the technological view to enable us to spot where interactions worked well together, or poorly producing contradictions.

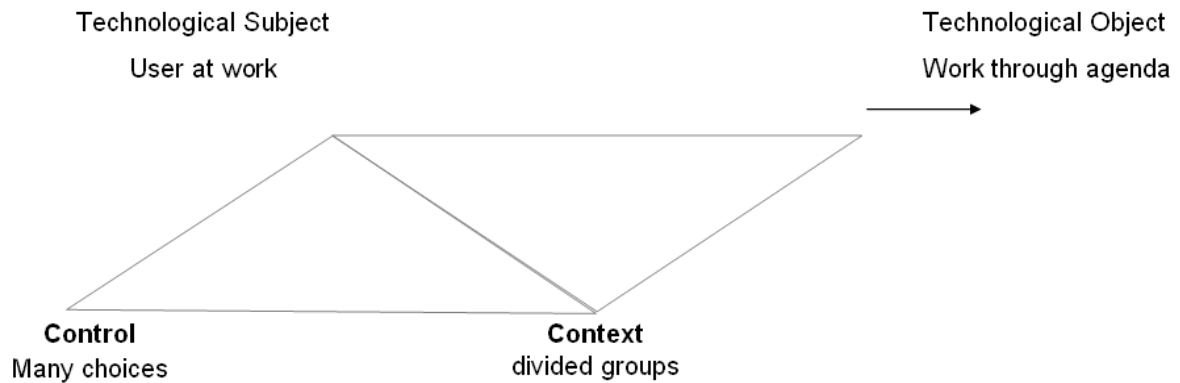


Figure 8: a subsection of the technological activity triangle for trial 1

For example the section of the activity triangles shown in figure 8 can be extracted from this overall triangle. This represents the need for the user to work through the agenda of tasks, link up with groups of other users, and choose the same tools to work with. Following the approach of Mwanza (2002a), these nodes can be considered to form a pair of questions:

How is it that the user at work operates with divided groups to work through the agenda?

How is it that the user at work controls the many choices to work through the agenda?

The answers to these two questions are in conflict as to work effectively in groups the users must be using the same tool at the same time, while the many choices available to the user in the system enabled individual users to choose different tools to achieve the same ends. Evidence for this conflict came from observations and feedback: as one participant said, "Sometimes [I] don't know who is there – too much information on the screen." And from another there was a "[need for] several communication channels at the same time". Viewed from the technological layer this means that the task information needed to ensure shared views; as feedback to the developers this strengthened their need to simplify some aspects of the interface. Viewed in the semiotic layer however this contradiction means that there is a need to construct the interactions in such a way that people would act together more by adjusting the scenarios and the way co-workers interacted.

This analysis approach was repeated for each case of concern and issue that came from the evaluation with the aim to provide added ways to explain the results of our evaluation and to explore where solutions could be found by adjusting the usage design and the technical implementation. The result was to produce maps for both support aspects and contradicting aspects. It is interesting to note that the same feature, e.g. fixed location, can act both in support and conflict. In this case there is *support* between fixed location, working through an agenda, and the task. There is *conflict* between fixed location, the user at work and the user selections of tools.

By carrying out this analysis on First Aid Trial 1 the outcomes could be fed into the design of First Aid Trial 2, to improve its effectiveness and provide a clear basis to be addressed in the second trial. Other observations from the trial led to the overall conclusions that for an improved match between the semiotic requirements and the supporting technology that there would need to be some changes to how the system worked and to how the trial planned to use the technology. Changes were made to improve usability where the user was faced with choices and to help provide status information between users working remotely. At the same time, the way in which the task leader acted to moderate different groups and alert them of events needed adjusting to the planned working environment. The lack of mobility in the trials also needed to be addressed again by considering both levels and so a need to share information about where each user was located was added in to the semiotic layer to take advantage of the mobility available. In turn this generated new needs to capture that information at the technology level.

A joint effort therefore was made to revise the combination of the system and scenario for a retrial. A simpler interface was devised but also new technology was added to provide a means for synchronisation and sharing image information: mobile camera phones with SMS text messaging were supplied to update participants outside of the integrated system. This split of technology initially may seem a retrograde step, however it illustrates an important finding of the overall research that multiple device solutions were often appropriate in mobile situations.

## Trial 2

The scenario of trial 1 was adjusted to encourage greater mobility and encouraging greater continuity in communication so helping a uniform choice of tools. While the original trial had sought to prove the technology, this analysis gave the project the confidence to introduce its key research questions into the second trial. This meant we could address whether the system could genuinely operate in a mobile environment, and whether the first aiders could benefit from carrying out designated tasks in relation to their first aid experience.



Figure 9: Pictures used in support of second First Aid trial

A second trial was run in January 2005 involving six participants and one team leader all from the first aid community. Participants worked in pairs carrying out assessments of immediate actions based on cases presented on mobile device relevant to their immediate location, figure 9 shows images forming part of each case matched to three of the locations (multimedia laboratory, refectory, and café,). They then discussed and shared plans for actions with the other groups.

A familiarisation session took place to allow participants to get initial experience with the technology. The main trial then took place two days later over a period of about 1.5 hours. Each pair in the trial was monitored by an observer who could also provide technical support, if it was requested. The observers used a simplified observation card to record their observations in particular looking for evidence of synchronisation of activities (contraindications being confusion and working on different tasks to other pairs) and working on task (contraindications being discussion of system aspects and technical problems). The moderator completed a reflective report. All participants, the moderator and observers then took part in a structured group feedback session that was digitally videoed to produce a DVD for analysis. Participants also completed a questionnaire and there was a final debrief of the observing team.

This trial produced more positive results with feedback generally being more focused on the possibilities for use in practice and less on the technology difficulties. All participants agreed that the session had “gone really well” and that it had been “Good fun – able to relax and learn more”. The moderator reported:

“The trial seemed a great success in teaching terms. The participants all engaged with the activities set, and clearly showed a grasp of First Aid principles in the work they uploaded to the system.”

Both the provision of SMS contact and using pictures within tasks were positively commented on. It was pointed out by one user that with “SMS you have a warning signal, you can really hear that something is going on.” Using the camera phone increased interaction with the environment – those using the phone stood up and looked around before deciding on the picture to take. No one felt inhibited by carrying out this sort of activity in a relatively public location (lab, café, and refectory): “As soon as you are involved in the task [in a public place] you forget about other people there.”

The messaging improved the synchronisation between groups to greatly reduce the contradiction that was evident in the first trial where groups would be trying to communicate in different tools and at different times. The pictures themselves added to the involvement in the activity: “Uploading pictures is particularly helpful. ... Sharing things is most helpful, with the person you were working with and the other groups.” Having made this semiotic change in the scenarios and provided the technology to support it we could see it in action and have a much greater feel for seeing the evidence for mobile learning that was the overall goal of the project.

The model of challenge-based training received strong support. It was felt to be highly applicable to First Aid training especially as the current approach only reviews training at three-year intervals for re-certification. It was commented that: “For quieter people this is... much better than normal first aid training.” All saw the potential in taking part in such events run at about 6-month intervals; the existing approach meant that training was often never used while being faced with a challenge meant they would gain confidence from being able to recall key points. Sharing views and results was highly valued and confidence was gained by praise from each group for the others assessment within the chat. Learning outcomes were not assessed as part of the trial. In general, the trial had acted to confirm the value of previous training and raise confidence that everyone was “thinking exactly the same thing”. However during the feedback session it emerged that before the trial only one participant (with specialist defibrillator training) knew the location and availability of a defibrillator if it was needed for heart attack cases. All participants had picked up this additional information during the trial by sharing the group views and discussion.

## STEPS IN IMPLEMENTING THE METHODOLOGY

We have now used this approach to both plan a technical implementation (McAndrew & Taylor, 2000) and in reporting and running evaluation studies as described above. We feel that the activity triangles augmented by developing separate views offer us considerable power to explain situations and to gather complex collaborative situations into relatively compact representations. We have achieved this by using the approach flexibly and

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accepting that it can only be a partial and potentially biased view of the real situation. Our experience has encouraged us to develop a tentative position on how to implement approach.

1. Agree a set of labels that have meaning to those involved (our own labelling replaced rules, community and division of labour, with control, context and communication)
2. Produce a semiotic triangle linked to scenarios of use
3. Determine the aims for the trial based on a semiotic view
4. Produce a technological triangle linked to the features in a system
5. Determine the main technological issues
6. Gather information from a trial
7. Relate that information first to the technological view
8. Match through to the semiotic view
9. Use both together to explain and adjust the situation
10. Iterate through steps 2 to 9.

Throughout this approach the evaluator needs to remain involved and flexible.

## REFLECTIONS AND CONCLUSION

Large scale projects such as MOBIlearn have inherent problems which can effectively sabotage collaborative effort so that, in order to complete, partners fragment and go off to do their own bits, thereby discharging their individual responsibilities, but not taking advantage of the collaborative potential. Evaluators are only too well aware that, as projects disintegrate, fingers of blame are often pointed in various directions, sometimes even at the evaluators for delivering the message.

This paper has discussed a method that not only helps stakeholders unify their disparate views, but also allows a representation to capture the innate complexity of technology supported collaborative learning in a mobile environment. In other words, communication is not achieved at the cost of simplification. This proves to be important in the evaluation phase, where the representation can simultaneously display where systems and their activities are succeeding in their goal of supporting learners, as well as displaying points of failure and possible consequences. In reviewing the framework as presented by Sharples, Taylor and Vavoula (2007) Wali, Winters and Oliver (2008) consider it a weakness that only one application is described, and also that the two-level analysis is more complex than using a single activity system. The further example given here shows that the method can apply in other circumstances while the two-level analysis gives a representation that separates out of the complexity inherent in the situation in order to support communication of analysis.

Augmentation of the extended activity system is a fruitful avenue to explore, and future effort will be directed at deepening the analysis by developing tools to help with (a) drawing diagrams and (b) logging the sequence of diagrams as we move to ever more fine-grained representations. Whilst there is a general sense of 'deep enough' for a given purpose, we have not yet systematically mined the scenarios to see what happens as you go deeper. It will be interesting to see whether this simply becomes too complex to manage, or whether, with computer support, it yields more interesting perspectives. A similar process of two-stage analysis of evaluation data was also applied in working with a system to support reuse of open educational resources (OER). In that case (McAndrew, Santos, & Godwin, 2007) the analysis both revealed the tension in the rules and community concerning the tools and circumstances for editing of shared content, and also helped communicate these to the development and academic teams. It is worth noting that in this case the conventional labels for the axis ("rules", "community" and "division of labour") were used as some of the stakeholders were familiar with these and so communication was aided, rather than hindered, by using labels that were recognised even if not immediately understood by all.

The dimensions of communication we have considered in this paper are between technological and the semiotic (design) points of view. In Vavoula and Sharples (2009) they draw attention to three levels – micro, mesa and macro – each of which needs to be understood in relation to the others. A suggestion that we have yet to explore is to construct three distinct activity representations using the terminology appropriate to each level. We believe that attempting to do this would be a worthwhile exercise and likely to reveal new perspectives, however comparing two activity systems that represent the same situation from different perspectives is already a fairly complex exercise and extension to three views may cause implementation problems.

From the point of view of the project, we feel that the task model and evaluation approach served their purpose well, and that we managed to analyse a very complicated situation to improve not only the user experience, but also the First Aider experience. Analytic approaches that aid evaluation and improve communication are not commonplace and so the development of shared activity representations is a potentially valuable contribution to the evaluators' toolset.

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